

enter the fin channels 144. An additional advantage of the partial fins 140a is reduced pressure drop for the fluids flowing through the process microchannel 110 as a result of providing the additional space 145 for flow.

[0040] The fins 140 may have a porous material overlying part or all of the exterior surface 148. This is illustrated in FIG. 3 wherein porous material 147 overlies exterior surface 148 of fin 140. The porous material may be in the form of a coating, fibers, felt, foam, or other non-dense substrate. The pore size openings may range from about 3 angstroms to about 100 microns. The catalyst or sorption medium may be deposited on the porous material.

[0041] The exterior surface 148 of the fins 140 may include surface enhancers such as random fibers 147a extending from exterior surface 148 as illustrated in FIG. 4, or protrusions 147b extending from exterior surface 148 as illustrated in FIG. 5. The fibers 147a and protrusions 147b may have lengths ranging from about 0.001 to about 0.3 mm, and in one embodiment from about 0.01 to about 0.1 mm. The catalyst or sorption medium may be deposited on the fibers 147a or protrusions 147b.

[0042] The fins 140 may either be continuous or discontinuous along the direction of flow as indicated in FIGS. 7-10. Advantages of discontinuous fins include the ability of providing a thermal block to reduce the contribution of axial conduction. Another advantage is the ability to integrate a fin structure into process microchannel employing staged oxidant addition along the length of the channel. The section 151 (FIGS. 7 and 8) with no fins may be positioned next to an oxidant inlet port, jet, nozzle, or other mechanism for introducing the oxidant into the process microchannel. The oxidant can then fully or partially mix with the fluids flowing through the process microchannel before entering the next fin region.

[0043] In one embodiment, the fins 140 may not all be the same length as illustrated in FIG. 9. Some fins 140 may extend down the entire length of the process microchannel 110 while other fins may extend only part way. This embodiment is advantageous for some reactions where the mass transfer resistance is highest at the front of the reaction zone. The more closely spaced fins reduce the transport distance of reactants to the catalyst or sorbent wall. The mass transfer time is roughly equal to the diffusion distance squared divided by the mass diffusivity. As the reaction or sorption proceeds, there may not be a need to continue this close spaced fin arrangement down the length of the zone. This has the advantage of reducing the overall pressure drop. An additional advantage is the enhanced heat transfer that is present where the fins are more closely spaced. It may be advantageous to transfer considerable more heat near the front of the reaction zone where the concentration of the reactants are highest. The additional fins add extra heat transfer surface area plus the reduced hydraulic diameter further increases the local convective heat transfer coefficient.

[0044] An alternate embodiment is the use of fins 140 with different heights as illustrated in FIG. 10. Some fins may be relatively tall, while others are relatively short. The relatively tall fins may contact the upper wall 122, while others fill only part (for example, about 10% to about 90%) of the gap or height of the process microchannel 110. An advantage of this configuration is that it provides a reduction in overall

pressure drop by reducing occlusions to flow. This configuration may be used with some processes that require only a modest enhancement to surface area for either heat or mass transport.

[0045] The fins 140 may be directly formed in the base wall 120 as opposed to being inserted within the process microchannel 110. These fins may be formed using a slitting saw, photochemical machining, or electrochemical machining. As shown in FIG. 11, the flow path for the process may include a channel that is not occluded in one section and then enters a reaction or sorption zone containing fins. The fins may extend from one end of the base wall 120 to the other end, or they may alternately be stopped short within the base wall 120.

[0046] Fins that are formed ex situ and then placed within the process microchannel 110, may be made wide enough to fill one microchannel at a time, or they may be made wider to simultaneously fill multiple microchannels. FIG. 12 illustrates an example of a fin assembly that spans four process microchannels. These fins may be inserted during stacking of laminate sheets and then diffusion bonded to form an integral component. An advantage of these fins is that they provide additional support for the microchannel walls during bonding. The fins may alternatively be inserted after diffusion bonding and removed for refurbishment or replacement after operation of the process microchannels.

[0047] The catalyst or sorption medium may be deposited on the exterior surface 148, porous material overlying the exterior surface, or on the surface enhancers illustrated in FIGS. 4 and 5 using conventional techniques. These include washcoating the catalyst or sorption medium on the fin surface, growing the catalyst or sorption medium on the fin surface from solution, or depositing the catalyst or sorption medium on the fin surface using vapor deposition. The vapor deposition may be chemical vapor deposition or physical vapor deposition.

[0048] The catalyst may comprise any catalyst that is suitable for use in chemical reactors involving the use of fluid reactants. The catalyst may be a catalyst useful in conducting one or more of the following chemical reactions: acetylation addition, alkylation, dealkylation, hydrodealkylation, reductive alkylation, amination, ammonia synthesis, aromatization, arylation, autothermal reforming, carbonylation, decarbonylation, reductive carbonylation, carboxylation, reductive carboxylation, reductive coupling, condensation, cracking, hydrocracking, cyclization, cyclooligomerization, ammoxidation, water-gas shift, dehalogenation, dimerization, epoxidation, esterification, Fischer-Tropsch reaction, halogenation, hydrohalogenation, homologation, hydration, dehydration, hydrogenation, dehydrogenation, hydrocarboxylation, hydroformylation, hydrogenolysis, hydrometallation, hydrosilation, hydrolysis, hydrotreating, isomerization, methylation, demethylation, metathesis, methanol synthesis, nitration, oxidation, partial oxidation, polymerization, reduction, reformation, reverse water gas shift, sulfonation, telomerization, transesterification, trimerization, Sabatier reaction, carbon dioxide reforming, preferential oxidation, or preferential methanation.

[0049] The catalyst may comprise a metal, metal oxide or mixed metal oxide of a metal selected from Mo, W, V, Nb, Sb, Sn, Pt, Pd, Cs, Zr, Cr, Mg, Mn, Ni, Co, Ce, or a mixture of two or more thereof. These catalysts may also comprise